PATROL RIFLE OPTICS

Iron sights have accurately directed gunfire for hundreds of years and are hailed by some as the only sighting system necessary. They claim irons are simple, durable, quick to use at close range, and are capable of remarkable accuracy at long range. But are they really all that and just how useful are they in the law enforcement role??? The following gives insight as to ever-increasing use of optics by LE agencies and some criteria to use when choosing an agency optic:

Iron sights are simple in that all you have to do is line up your front sight in the center of your rear sight, then place this combination in the center of your target and keep it there when the gun fires. This is a relatively simple task for an experienced shooter with good visual acuity and a firm understanding of the 3 focal planes involved; for concentrating on the focus of the front sight, at the expense of the clarity of the rear sight and target, is the key to success here. All of these issues are what makes marksmanship a sport of concentration and control on the competitive range, and what makes these sights so complex to use while experiencing the stress of danger and the unknown while gun fighting on the street. These issues also make iron sights virtually useless in adverse lighting conditions where they cannot be seen very well unless assisted by the presence of artificial light.

On the range, stress is induced by the personal fear of failure or not performing well on a known drill that must be completed in a known time frame; many people can control this kind of "known" stress while some cannot. Controlling this stress becomes the difference between winners and losers on the competitive range. On the street, in a LE scenario that is "tense, uncertain and rapidly evolving", the fear of severe injury or death creates a huge amount of "unknown" stress that very few can control in order to properly perform some of the required marksmanship skills. During this LE encounter, the target is most likely moving and the officer is probably moving as well, making the use of irons sights even more difficult to use correctly. Controlling this stress and the sights becomes the difference between life and death on the street.

During a LE lethal force confrontation, officers' visual input is about 90% of their perception as they are constantly re-evaluating the evolving situation. At a time when an officer desperately wants to continue watching the suspect's every move as the officer makes the decision to shoot, marksmanship requires that the officer stops focusing on the suspect and re-focuses on the front sight. We know from many debriefings that some officers will stay focused on the suspect and deliver less than effective fire, while a few others will use their sights properly and deliver more accurate and effective fire. The former will usually result in missed rounds that endanger the community and marginal hits to the suspect which delays his incapacitation and requires more and more shots to be fired in order to finally stop him. The latter group, while effective in quickly stopping the suspect with fewer better hits, missed the critical last split-second visual input of the suspect dropping his gun as the well focused front sight was being lined up and the trigger pressed. This last bit of visual input may have allowed this latter group of officers to realize that the situation had just dramatically changed and that they, now, did not have to shoot at this specific moment in time.

Optics, which may be less simple in design than iron sights, are much simpler to use as they work using a single focal plane. The optic has a single sighting point, commonly referred to a reticle, rather than both a front and rear sight, that remains in the same focal plane as the target allowing the user to see both target and sighting point clearly and focused. The clear sighting point (which may be crosshairs, a red-dot, an amber triangle, etc.) is simply placed on the clearly seen target and the trigger is pressed when appropriate.

Accupoint TR24 1x4

Aimpoint T-1 Micro

Leupold CQT

This allows the officer to continue to focus on the suspect during the entire confrontation and this allows for the best decision-making possible when evaluating visual input. Some optics are designed to provide a level of magnification and this ability to see objects more clearly may allow an officer to determine that the object in a suspect's hand is a silver-colored cell phone rather than a nickel-plated semi-auto pistol. Essentially, optics provide the officer with more ability to acquire, identify and accurately engage the threat more rapidly, while still receiving updated visual input, than is possible with iron sights. Many of these optics will allow the officer to keep both eyes open which helps to enhance the speed of acquisition, depth perception, peripheral vision, and the ability to track moving targets. Visual acuity problems that make the use of iron sights very difficult for some LE personnel (less than perfect vision, use of bifocals, etc.), are generally diminished with the use of optical sights, and with some optics, officers' visual acuity is actually enhanced.

When training department personnel, the simplicity of using these optical sights, allows personnel to reach an acceptable level of accuracy more quickly, with less expenditure of training time and ammunition, than when using iron sights. An added advantage is that once the optic is zeroed on a particular rifle, all personnel who use that rifle should have the same point-of-aim/point-of-impact, which should cut down on the amount of time spent on the individual zeroing of iron sights. This issue can also impact agency decision-making as to whether "pool" rifles are a viable option when considering the expenditure of funds while equipping personnel with rifles. During this time of ammunition shortages, spiraling ammunition prices, and the ever lack of training time available, this is no small matter. The U.S. military has recognized this issue and has transitioned to various kinds of optics for use on their rifles/carbines, machine guns, and automatic grenade launchers.

The Marine Corps, traditionally the last organization to upgrade equipment according to former Marines, has a contract with Trijicon to provide an ACOG (Advanced Combat Optical Gunsight) for every rifle in its inventory by the close of 2009. The U.S. military has found that its current issued optics are durable, reliable, and accurate.

When we take a look at the current optics that are suitable for Patrol Rifle use, we can break them down into following two general categories: non-magnified Red Dot Sights (**RDS**), and magnified tubular scope sights.

Red Dot Sights are usually battery powered and have an illuminated reticle (usually a red dot) that appears centered in a single lens or a short dual lens tube. These sights are very fast in target acquisition as they allow the officer to keep both eyes open as the sight is used. The fact that the red dot does not have to be centered in the lens, in order to be accurate, allows this sight to be quickly used from awkward head positions or while using a gas mask, which is sometimes an impossible task when using iron sights. The intensity of the illuminated reticle may be manually adjusted or may adjust itself automatically to the varying light conditions; some of those that are manually adjusted may have low level settings that can only be seen with night vision devices. The officer simply focuses on the target, superimposes the red dot on the clear target and presses the trigger. We refer to these sights as the generic Red Dot Sight but the actual reticle may vary from a red dot, to a chevron, triangle, or crosshair; and may be green or amber in color. Good examples of the RDS are: the Aimpoint **Comp M4S** and **Micro T-1**, the Trijicon **Red Dot**, the EOTech **HWS**, and the C-More **ATAC**.

The **Aimpoint RDS** is actually several different models with the most current being the **Comp M4S** and the much smaller **Micro T-1**. The U.S military has found the Aimpoint RDS to be the most robust sights currently available, waterproof, and far outclass any other electric optics as far as battery life. The below 3 photos show an AR w/Aimpoint that was unintentionally run over by multiple 18-wheelers smashing it to pieces on the left, the middle photo is the smooshed Aimpoint, and the dim right photo shows that the red dot is still visibly working.

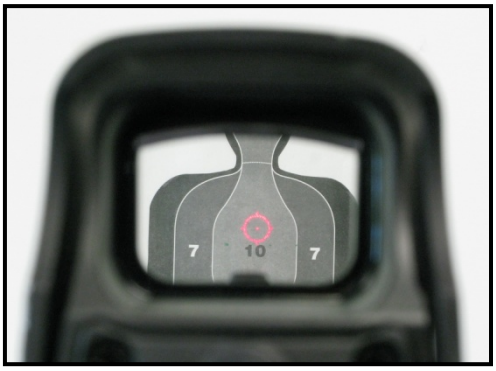


When left **"on"** 24/7/365, with the manual recticle intensity switch on a setting that allows the dot to be readily seen in all but the brightest lighting environments, the single AA battery of the Comp M4 will last for three years and the single CR2032 battery of the Micro T-1 will last longer than a year. The Comp M4S weighs 14oz., with factory mount and spacer, while the much smaller Micro T-1 weighs only 4oz. with factory supplied mount.

Both of these optics work well in conjunction with Back-Up Iron Sights (BUIS) and are available with or without Night Vision settings.

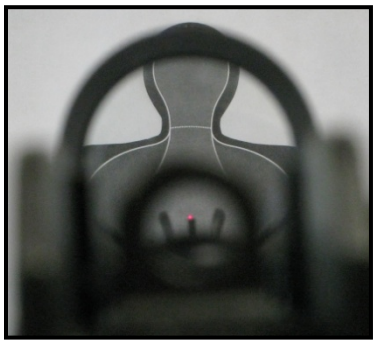
The **Trijicon Red Dot** is a very small single lens sight that weighs only 0.5 oz., due to the polymer housing and acrylic lens, and is currently being used on rifles, pistols, and shotguns. This sight does not have an "on" switch so it is constantly "on", it's single CR2032 battery lasting more than 2yrs while "on" and 4yrs if the lens cover is shielding the lens. The intensity of the dot is self-regulating by a sensor that sets the dot brightness according to the surrounding lighting conditions. This sight is seeing combat time in Iraq and Afghanistan, as a "CQB" sight, when attached to other larger rifle-mounted magnified optics such as the ACOGs. In order to survive in these combat conditions, an enclosed mount was developed by LaRue Tactical to better protect this sight. The just-released improvement of the Red Dot is the **RMR** (Ruggedized Miniature Reflex) which is made out of more durable 7075-T6 aircraft aluminum with a hardened glass lens, increasing its size slightly and its weight to 1.2 oz. The battery-powered LED RMR will run for over a year on a single CR2032 battery, and is also available as a dual illuminated sight that uses both fiber optics and tritium to illuminate the reticle with no batteries at all. These sights are not night vision compatible and will generally work with BUIS.

The **EOTech HWS** (Holographic Weapon Sight) is very popular with officers who claim that the larger field of view through the single lens window and the more prominent "circle/dot" reticle gets them on target faster than any other sight currently available. The U.S. military procured thousands of these sights for Iraq but, reportedly, they did not hold up as well as the Aimpoint. Less than reliable circuitry and sight mounts coming loose seemed to be the two biggest issues, while uncommon "N" batteries were a supply problem and had short life span. Additionally, the circle/dot reticle consumes so much battery life that an automatic shut-off is still installed on all models, limiting "on" time to either 4 or 8 hrs, depending on which of three collocated buttons you pushed to turn it on, one of those 3 collated buttons being the "on" button for the Night Vision mode. This sight is also compatible with BUIS. Many improvements to this sight have been made over the years, including an AA battery model, the most current CR123 battery model, a single 1moa dot reticle, a circle with multiple dots for farther ranges. Even with the new single dot reticle, there is still the automatic shut off feature. The early "N" battery model ran 100hrs and is no longer made, the current AA model runs 500hrs, and the newest CR123 model runs for 500-600hrs.



The **C-More ATAC** is another single lens RDS, that is married to a modified flat top carrying handle that retains its A2 iron sight; a RDS and rear iron sight that comes as a one-piece unit. This sight has to be turned "on" and the intensity level of the dot manually adjusted for the current lighting conditions. The ATAC uses a 1/3N battery which will run this sight for about 2 months if left "on" with a fresh battery.

The ATAC is designed to have the dot co-witnessed with the top of the front sight when viewed through the rear sight with the normal iron sight head position as pictured at the right.



The advantage to this is that you can verify that the dot is still zeroed correctly with the irons prior to use or after the rifle has received a severe impact. The officer can still quickly use the dot without regards to the BUIS like with the other mentioned RDS as pictured at the left.

Instructor Note: **Since it is possible for any RDS to fail to work properly, it is prudent to train officers to use the RDS "window" as a rear aperture to the AR's front sight. It is possible to maintain reasonable accuracy to 25yds, depending on the optic, when using this technique.**

Magnified Scope Sights are more like the traditional hunting scope, they are longer in length, contain more lenses than the RDS, and may have illuminated or non-illuminated reticles. These scopes may not be as quick and flexible to use as the RDS as they require the officer's head to be in a more specific position, but not as specific as iron sights require. If considering a magnified scope, choose a low power variable like a 1-4X or 1.5-5X. This gives you the ability to carry it on 1X (no magnification) or 1.5X (very little magnification) so that you can use it at close range almost as quickly as you could with a RDS and generally faster than regular iron sights. If the situation called for it, you can adjust the magnification up to 4X or 5X to more clearly discern smaller objects or deliver a more precise shot at longer distances to a more clearly identifiable target.

The downside of increased magnification is a much narrower field of view through the scope (think of looking through a long pipe) which may make rapid acquisition of the target slower and more difficult, and the tracking of a close range moving target next to impossible. If you are looking at a fixed power scope then stick with those in the 1.5X range as even going to a 2X begins to cause you to lose the advantage of rapid target acquisition during those normally close range police encounters. None of these types of sights are designed to have BUIS viewed through their lens systems. Good examples of these magnified scope sights are: the **Trijicon Accupoint TR24 1-4X** and the **Compact ACOG 1.5X**, the **Leupold Mark4 CQT 1-3X** or **MRT 1.5-5X** or **Prismatic 1X.**

The **Trijicon Compact ACOG 1.5X** and **Accupoint TR24 1-4X** can be had with various reticles that are illuminated by a combination of fiber optics and tritium. They do not have to be turned "on" and the illumination of the tritium will last about 10yrs before it needs to be replaced. The Accupoint is the size of a traditional hunting scope and is mounted with 30MM rings like many other rifle scopes. The Compact ACOG is much smaller in size and is ideally suited for use on ARs with fixed carry handle as the Compact's integral mount fits down into the carry handle groove, lowering the ocular lens right over the top of the rear aperture sight, but leaving a hole through the mount through which the rear aperture can be viewed.

Leupold's Mark 4 MRT 1.5-5X can be had with various reticles that are seen in black like a normal hunting scope in lighted conditions while parts of the reticle glow red from a battery powered illuminator when it is turned "on" and adjusted for brightness. A 1/3N battery is used to power the illuminated reticle and it will last for 10hrs at maximum brightness. This sight is also mounted with regular 30MM rifle rings.

The **Mark 4 CQT 1-3X**was designed for AR flattops and comes with its own mount. The reticle is a circle/dot that is etched into the lens and is seen as black in regular light but glows amber when the illuminator is turned on and adjusted for brightness. This large sight is powered by a single AA battery and will run for 7hrs at the maximum brightness.

The **Prismatic 1X** seems to be a smaller version of the CQT as it has an etched reticle that glows amber when illuminated but has no option of magnification; it also is designed with its own flattop mount. The illuminator is powered by a 1/3N battery and at full brightness will last for 10hrs. One advantage to all three of these Leupold optics over most of the other electric-powered sights is that if the battery fails to illuminate, the reticle is still seen in the black configuration and can be used for aiming if there is enough ambient light.

Mounting the Optic on today's M1913 flattop rails is a breeze as this is precisely why these rifles were designed this way and optic manufacturers have had 15-20yrs to work these systems out:

1. The mount should solidly hold the optic to the rifle so it doesn't vibrate loose under the constant vibration of a moving patrol car or the recoil impulses of firing. Think about using #242 "blue" Loctite on any clamping screws and cross-bolts and color-line mark them so you can easily see if any start to loosen.

2. Good mounts are designed to be removed from the rifle and then re-mounted without loss of zero. Find the best place on the "T" marked 1913 rail to mount the optic, that gives you the best eye-relief or field of view, and mark the mount with the "T" number of the cross slot that the cross bolt/block drops into. If your rail is not "T" marked, you can color the specific cross cut and bolt/block so that you return it to the same place every time it is remounted. Before tightening the mount to the rail, push the mount forward in the cross cut while pushing the stationary side of the mount flush against the side of the rail. This will remove any "play" in the cross cut and will ensure that the mount gets back to exactly the same place each time the sight is re-mounted. Now, tighten and Loctite as necessary.

3. RDS mounts should place the optic high enough so that the BUIS can be zeroed and viewed in the bottom 1/3 of the optics field of view. While the dot and the irons can be co-witnessed in the center of the field of view by manipulating mount height, many users claim that this leaves the field of view "cluttered" with the front sight base protruding up into lower half of the field of view.

The fixed carrying handle ARs are more problematic for mounting optics as they were never designed to do this. Placing optics up on top of a carry handle usually ends up placing the optic up so high a cheek/chin weld is difficult and the mechanical off-set of the muzzle and line-of-sight becomes extreme. This is one reason why the small Compact ACOG nestled down into the carry handle becomes such a good choice.

Goose-neck or cantilever mounts can attach to the carry handle so that a RDS may be mounted lower and forward of the carry handle so that the BUIS can be used while viewed through the RDS. Using this kind of mount may put the RDS so far forward that it may interfere with some locking racks, so test this before selecting this technique.

Mini-14 rifles and M-1 carbines can easily mount a RDS by installing an after-market railed upper handguard like those offered by Ultimak. This allows an RDS to be mounted low and forward of the receiver where they are very easy to see and don't interfere with the ejection of empty casing like a receiver-bridged optic might. BUIS use may be blocked depending on the mounting/optic combo so be sure to check this.

Selecting an Agency Optic may be different than choosing a personal optic and as your agency's subject matter expert on rifles you should have an understanding of why that may be so. You will need to recommend an optic that is virtually cop-proof and easy to use as many officers are not gun-savvy types who cherish and protect good equipment that they haven't paid for. Cop-proof in that it should be:

1. Durable – able to take the callus abuse doled out by the average patrol officer

2. Easy to use under stress – try to eliminate the use of on/off push-buttons or dials

3. If battery-powered, battery life should be long enough that all optics will have the same battery-change date that is scheduled for once, worst case scenario, twice a year.

4. Locking rack ready - the optic should not compromise the use of a locking rack because these guns **should** be racked up front in the driver's compartment where the action is. Patrol rifles that are stored in the trunk will only be used as an after-thought as accessing them there is too cumbersome, dangerous, and time-consuming during the rapidly evolving situations that patrol officers often get into.

With these criteria in mind, one of the better choices for a flattop AR would be the Aimpoint **Comp M4S** or **Micro T-1 on a LaRue Tactical pedestal mount**. They are combat-rugged; you turn it on once, leave it on, and replace the battery yearly so that it never comes close to going dead. Either of these sights will not compromise current locking racks. The mounts from **LaRue Tactical** are well made, extremely secure, and return to zero without fail if removed from the M1913 rail. If magnification is deemed necessary, then Trijicon's **Accupoint 1-4 4** scope, in the **LaRue Tactical SPR-E** mount is an excellent choice as it works like a RDS at 1X but provides up to 4 times magnification when needed, and its self-illumination needs no on/off switch or battery. For all these same reasons, the Trijicon Compact **ACOG (TA-44)** is one of the better optics to mount on a fixed carry handle AR; small, light-weight, rugged, doesn't need to be turned on, doesn't compromise a locking rack, and isn't mounted up so high that it severely increases the mechanical off-set of the muzzle/line-of-sight.

In conclusion, the optics available today that are suitable for LE Patrol Rifle purposes are light years ahead of those made just 10 years ago. Some manufactures make an extremely durable product that feature optical clarity, operational controls, and low-light reticles that are virtually cop-proof. These optics will allow an officer to deliver rapid, accurate, rifle fire that will help to save the lives of our citizens and officers. Since these optics allow for visual clarity of the suspect's actions, officers may be able to save some suspects lives as well and, in a perfect world, that should certainly be our ultimate goal.

Zeroing the Optics/BUIS or standard Iron Sights –

INSTRUCTOR NOTE: All duty patrol rifles are to be zeroed with duty ammunition – zeroing a rifle with one type of ammunition does not guarantee that a second type of ammunition, even if it is the same bullet weight, will shoot to the same point of aim; therefore, zero with duty ammo.

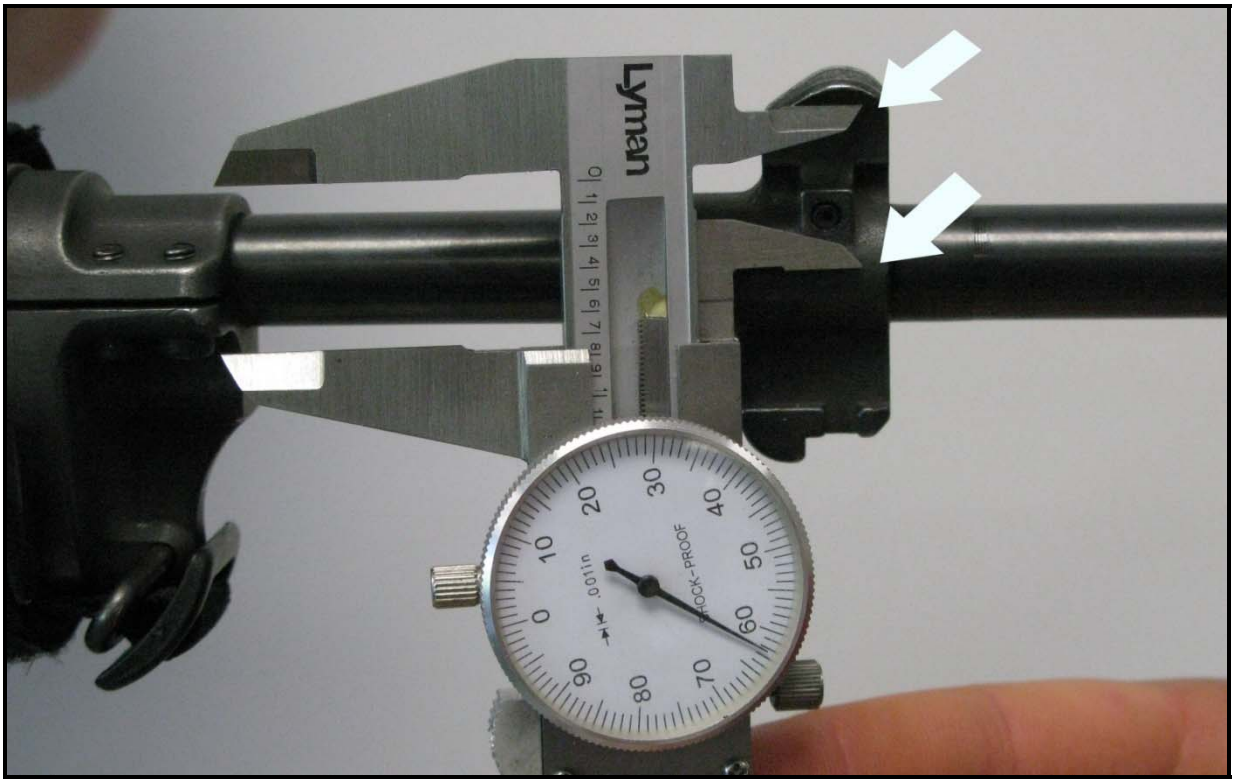
The example that we will use here to show zeroing will an iron-sighted AR-15 carbine, with 16" barrel, shooting the standard Winchester 5.56Nato 55gr FMJBT bullet @ 3000 feet per second; this combination of barrel/ammo is quite similar to that carried by most LE agencies today.

The **first concept** that we need to understand is that the bullet fired from any firearm begins to fall as soon as it leaves the muzzle. The bullet is constantly being slowed down by air resistance while at the same time being pulled to earth by gravity. Air resistance and gravity team up to cause the flight of the bullet's travel to describe an ever-increasing curve toward the ground; this curve is known as the bullet's trajectory.

The **second concept** that we need to know is that our line-of-sight thru the sights of a firearm is a true straight line. It is important to know how high above the center of the bore that this line-of-sight is when calculating where to zero a firearm as this distance may vary from firearm to firearm. The front sight of a pistol may only be ½" above the center of the bore, the scope of a sniper rifle might be 1.5 " above, the iron sights on an AR-15 are 2.6" above, and an EOTech that is mounted on a rail and attached to the carrying handle of an AR-15 is 4.5" above. These differences in the vertical height of line-of-sight from the center of the bore are called "**mechanical off-set**", and may play a significant part in the zeroing process as we try to match the line-of-sight with the most useable part of the bullet's trajectory curve.

The mechanical off-set distance is one of the most important pieces of input data that is required in using ballistic software to calculate the "best" zeroing distance for the particular firearm that you are using. Measuring mechanical off-set can be done with calipers or a ruler, measuring vertical distance from the center of the bore to the top of the front sight post or center of the optic's field of view as demonstrated in the following two photos.

Measure the vertical distance from the middle of the scope tube to the seam of the handguards to get the mechanical off-set of this AR-mounted Trijicon Accupoint TR24 1X4.

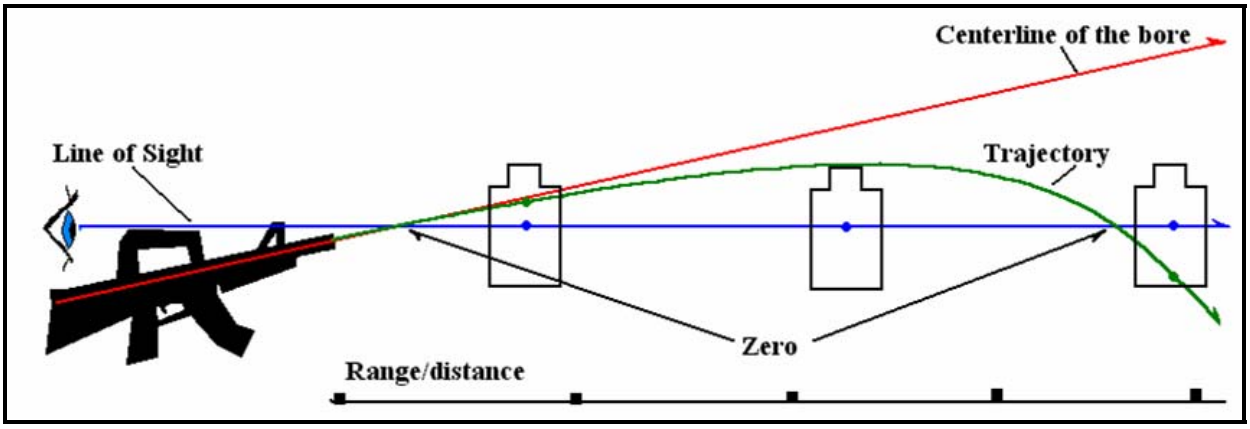


This is the mechanical off-set measurement on the iron sight of the Gov't Mini-14; from the top of the front sight post (not the protective wings) and the center of the barrel.

The **third concept** we need to understand is that of an "acceptable" accuracy standard; this relates to what size target area we need to hit. For this LE example, consider that a 6" sphere

placed in the high-center chest of a suspect seems to encompass the heart, lungs and major blood vessels that we generally teach all LEOs to aim for as their primary target area. The concept is that while we will aim for the center of this 6" circle, we will "accept" a hit anywhere in this 6" circle as a "good" hit as it will destroy a certain amount of the heart, lungs and major blood vessels that we are targeting.

With these three concepts in mind, let's start the zeroing process knowing that the line-of-sight of our iron sights is 2.6" above the parallel line of the center of our bore. If we aim at the center of the 6" sphere, placed 3 feet in front of our muzzle, the fired bullet will hit 2.6" low in the sphere due to the 2.6" of mechanical off-set. While the bullet hit nowhere near where it was aimed, it is still an "acceptable" hit because it was in our target zone. Now, place the target out at 40yds and repeat the shot; it will now hit 3.25" low from the center of the sphere and 0.25" low outside of our "acceptable" target zone due to the downward fall of the bullet caused by air resistance and gravity. Any more shots at longer distance will only find the bullet hitting lower and lower as the distance to targets continues to increase. To compensate for air resistance and gravity, it is necessary to adjust our sights in such a way as to cause the barrel to be angled upwards in order for the bullet's trajectory arc to overlap the line-of-sight. When this is done correctly, this bullet will still hit about 2.6" low at 3 feet but will now be climbing upward in our 6" target zone as the distance to target increases, intersecting the line-of-sight, climbing higher into the upper half of the 6" target zone, before finally arcing over and falling back through the line-of-sight, into the low half of the target zone, and finally falling out of the target zone as it plunges to earth. Knowing that this is the way that our bullet will act, we want to zero our sight in such a fashion that our bullet will stay in our 6" target zone for the longest possible distance; this distance is referred to as our "point-blank zero"(PBZ).



It is helpful to zero our sight at a specific distance so that the point-of-aim (POA) is point-of-impact (POI) and that a standard procedure for zeroing is established. This distance is the point where the bullet crosses the line-of-sight on the upward climb of the bullet's trajectory arc, in other words, the bullet will hit exactly where we are aiming. With the AR-15/ammo we are using, that distance will be **50yds**, the bullet will continue to rise until it **peaks 1.9" high at 135yds**, then passes downward through the line-of-sight **again at 215yds**, and finally drops out of the 6" target zone at 260yds. You now have a standard zeroing distance for this gun/ammo

combination that gives you a **point-blank zero out to 260 yards**; in other words, any round fired directly at the center of the 6" target zone will strike somewhere in the target zone from muzzle contact to 260 yards.

If you only have a 25yd range to zero on, you can achieve that same **50yd zero** described above by adjusting sights to have bullet impact be **1.2" low** at 25yds. If you choose to zero your sight so that POA = POI at 25yds with this AR/ammo combo then you will have increased the upwards angle of your barrel so that your trajectory will look like this: the bullet will travel upwards from muzzle to 57yds where it exits the top of the 6" target zone, continues upwards until it arcs over 10" high at 214yds, heads downwards into the target zone again at 350yds, exiting the bottom of the 6" target zone at 395yds. Now, your **point-blank zero** is only to 57yds and again from 350-395yds.

You should now understand that changing the barrel/bore angle to the line-of-sight is an issue of angles that is exacerbated by increasing mechanical off-set. We never notice this with handguns as the sights are so close to the bore that we never notice much difference in POA vs. POI at the distances we normally shoot handguns and generally zero them at 25yds. Low mounted iron sights such as those on the Mini-14, M-1 Carbine, or M-14 are also successfully zeroed at 25yds. Even a bolt action rifle, with scope mounted 1.6" above the bore, would only be ¾" high outside of the 6" target zone at 150yds as it arced over. So with the AR-15 family of weapons, you also must be concerned about mounting optics much higher than the iron sight example described above. Flattop receivers will keep most optics down close enough to the iron sights that the same 50yd zero can be used. Mounting some optics on top of a fixed carry handle requires a base rail mounted on the handle and then the optic mounted on the rail; mounting an EOTech in this manner places the reticle 4.5" above the bore. This makes for a even steeper angle when zeroed at close range such as 25yds as the bullet will enter the 6" target zone low at 7yds and will leave high at only 42yds, arc over 29" high at 314yds, and plunge down through the 6" target zone between 525-555yds. Not a very useful point-blank zero. This particular optic combination needs a 67yd zero which produces a 300yd point-blank zero, minus the first 20yds where the bullet is low outside the target zone as it begins its climb up from the muzzle. If zeroed on a 25yd range, this optic combination is adjusted so that the POI is 2.6" low at 25yds.

The following are some examples of optical combinations and the best distance to zero to maximize a 6" target zone point-blank range with the 55gr FMJBT @ 3000fps:

Sight Mechanical Off-Set	**Off-Set**	**Zero PBZ**
AR Iron sights	2.60"	50yd zero – 260yds
AR Carry Handle:		
EoTech on B-Square rail	4.50"	67yd zero – 300yds
Leupold Prismatic on B-Square rail	4.50"	67yd zero – 300yds
Leupold CQT on B-Square rail	4.50"	" " "
Aimpoint Micro -T on B-Square rail	3.85"	57yd zero – 299yds
Trijicon Red Dot on B-Square rail	3.85"	" " "
Trijicon ACOG TA-44 1.5 X 16	3.25"	50yd zero – 290yds
AR Flat-Top:		
Leupold M-4 in LaRue SPR-E	2.70"	50yd zero – 265yds
Aimpoint M4S w/factory mount	2.75"	50yd zero – 270yds
Leupold CQT w/factory mount	2.80"	50yd zero – 273yds
Accupoint 1.25 X 4 in B-Square mount	2.90"	50yd zero – 278yds
Bolt Guns:		
Savage 110w/Warne Rail/3 X 9 Burris	1.60"	50yd zero – 210yds
Savage 10w/Leupold M4 3.5 X 10	1.80"	50yd zero – 220yds
Mini-14 – Iron sights	0.875	20yd zero – 240yds

Most of the above external ballistic/trajectory information can be obtain by using one of the many ballistic software programs that are currently available. The information above was calculated using the RCBS.Load 3.2 program and those optic combinations that were tested proved the software calculations to be remarkably accurate.

Canting the Rifle

Canting the rifle is best described as rotating the rifle sights to the right or left while the muzzle stays pointed at the target, such as when shooting under a vehicle. Maximum 90 degrees right or left canting changes the conventional bullet trajectory as the rifle is no longer launching the bullet up, vertically, towards to the line of sight but instead, over, horizontally, to the line of sight. If the AR rifle is canted 90 degrees to the right, the bullet is now launched to the right and will continue to travel farther and farther right as the range continues to increase. Additionally, the bullet exits the muzzle on the same horizontal plane as the sight and gravity begins to pull the bullet to earth as soon as it leaves the muzzle, unlike when the rifle is fired in the conventional upright manner. While a canted AR rifle's trajectory is changed, there will not be a significant problem of hitting the 6" torso target zone at typical LE engagement distances of 50 yards or less, but there could be an issue if one was forced to hit a specific small target, such as a suspect's leg at very close range while shooting under a vehicle. The mechanical off-set will have the bullet hitting about 2.5" ***left*** of the reticle (point-of-aim) at 5 yards as it starts traveling

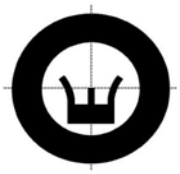
to the right to meet the line of sight at 50 yards. With the average ankle/calf of a man varying between 3"-5" in diameter, a shot that hits 2.5" ***left*** of the point of aim will slightly graze or completely miss if the reticle is centered in the lower leg. The officer would have to hold off the right of the leg in order to make a hit in the center of the leg in the same fashion that he would need to hold high in order to hit center in a conventional close range head shot. As the distance to target increases, the bullet will get closer to the line of sight until they meet at the zero distance and then the bullet will continue on to the right of the point of aim while gravity begins to have more effect and the bullet begins to drop below the point of aim. The examples below demonstrate the trajectory of a 90 degree right cant, from three rifles with different mechanical off-sets, using the above described 55gr FMJ ammunition:

OFF-SET	**10yd**	**25yd**	**50yd**	**75yd**	**100yd**	**150yd**	**200yd**
AR – 2.60" Iron sights	2" left	1" left	.5"right .5"low	2"right 1.1"low	3.5"right 2.2"low	7"right 5"low	10"right 9"low
Mini – 0.9" Iron sights	5/8"left	¼"left	.5right .5"low	1.1"right 1.1"low	2"right 2"low	3.3"right 5"low	5"right 9"low
AR – 4.5" EOTech on Carry handle	3.5"left	2"left	.5"right .5"low	3"right 1.1"low	5.5"right 2"low	10"right 5"low	15"right 9"low

(**data figures are the same when canting to the left, only the right/left designators are reversed**.)

The above data should clearly show that when a rifle is canted 90 degrees in either direction the bullet trajectory is radically different than when the rifle is fired in the conventional upright position. The normal AR rifle trajectory allows a Point Blank Zero that will hit somewhere inside of a 6" target zone to 250yds, canting the AR rifle 90 degrees will diminish the PBZ to about 75 yards depending on the distance of the mechanical off-set of the sights. For law enforcement officers, canting the rifle should not pose any significant problems in making torso hits at typical LE engagement ranges which are usually less than 75 yards. Officers should be reminded that when they change the orientation of the rifle from vertical to horizontal, the mechanical off-set changes to horizontal as well.

AR-15/M-16 IRON SIGHTS AND SIGHT ADJUSTMENTS



The majority of irons sights that are on most rifles that are suitable for use as patrol rifles are the combination of the simple front post/blade centered in a rear circular aperture. The most common US LE rifle in use is the AR-style rifle and the most common iron sights on them is the A2-style so our discussion will center on these sights but we will follow-up with the sights on the Ruger Mini-14. Let's make the distinction right up front that we are talking about zeroing iron sights on patrol rifles for law enforcement engagements and not for Olympic competition. In order to make this task as simple as possible we must first have an understanding the following concepts:

- **ZERO** - can be defined as the sight settings required on the rifle to shoot "point of aim = point of impact" at a specific distance. An AR-rifle's iron sights should be zeroed at 50yds in order to maximize the accurate use the bullet over the longest distance possible.

- **All duty patrol rifles are to be zeroed with duty ammunition** – zeroing a rifle with one type of ammunition does not guarantee that a second type of ammunition will shoot to the same point of aim; therefore, zero with duty ammo.

- **Are these individual-issued rifles or "pool" rifles??** - If these are "pool" rifles then the best rifle shooter in the agency should fire **all** of these rifles during the zeroing process as it is important that the shooter be able to fire consistent small groups in order to zero properly. With this procedure, any officer is able to employ any agency gun - because all the guns shoot to the same point of impact. In theory, an officer may have to "hold-off' to hit the intended target. If this is the case, the individual officer's hold-off will be the same for every agency gun. In practice, the officer's hold-off is unlikely to be significant at patrol rifle distances. If rifles are individually issued then the assigned officers should do the shooting only if they are capable of shooting small enough groups during the zeroing of that rifle.

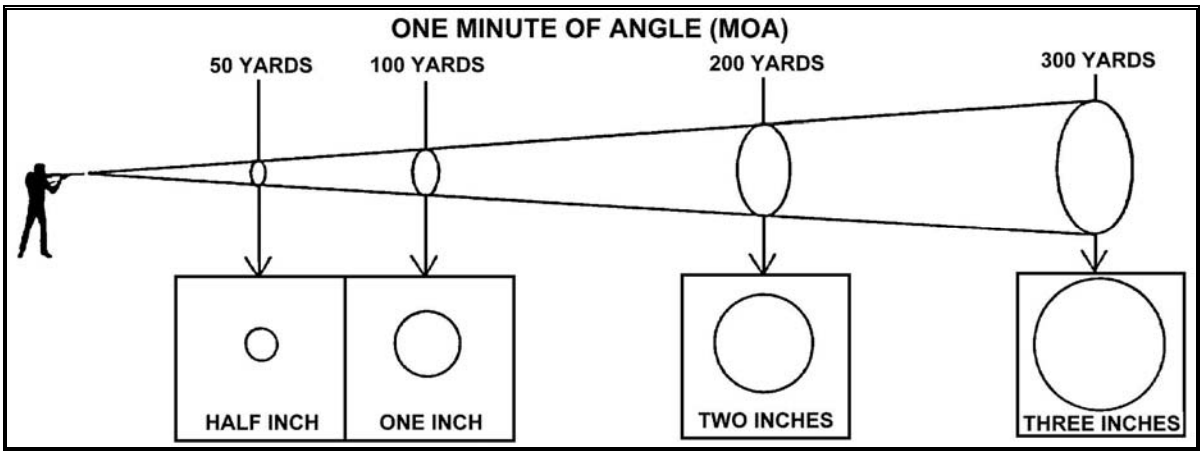
- **Move the rear sight in the *same* direction that you want the bullet impact to move** - If your bullet hits to the *right* of your target, you will need to move the *rear* sight to the *left* to bring the bullet impact back *left* to the center of the target.

- **Move the front sight in the *opposite* direction that you want the bullet impact to move** – with an AR rifle, if your bullet hits *low* on the target, you will need to move the *front* sight *down* to bring the bullet impact *up* to the center of the target.

- **The dual apertures of the rear sight are at two separate elevations** - for a Patrol Rifle the large aperture (ghost ring, marked "**0-2**") should be considered the default or car carry aperture, used for low light, indoors, close range, hasty sight alignment, and can be used out to 200yds without any need to "hold-over". When the small aperture is rotated up, its

center is higher up on the blade than that of the large aperture, changing the zero to 300yds and aligning this aperture for longer range use in conjunction with the rear sight elevation knob. While this long range sight combination has little use for LE, knowing of this difference in aperture heights allows the shooter to use the small aperture for close range precision shots with less mechanical offset. This will become more clear when we get to the zeroing procedure.

- **Windage and Elevation** - Changing the sight position right or left is commonly referred to as "*windage*" changes while the up and down movement of the sight are "*elevation*" changes. These changes are generally referred to as "***clicks***" and each "click" of sight change will move the bullet impact a prescribed distance on the target, depending on the range to the target. Example, while one click of windage with an A2 rear sight will move the bullet impact ½" at 100yds, that same click will move the bullet ¼" at 50yds and 1" at 200yds. (see MOA below)



There are 360 degrees in a circle, with 60 minutes of angle in one degree. It is generally accepted that one minute of angle is equal to one inch at 100 yards. This equates to ½ inch at 50 yards, 2 inches at 200 yards, 3 inches at 300 yards, etc. Minute of angle is easily translated to rifle sight "clicks" as seen in the following chart:

Minutes of Angle (MOA) for Each "Click" on the Rifle Sights				
TYPE OF RIFLE	**Front Windage**	**Front Elevation**	**Rear Windage**	**Rear Elevation**
Colt AR-15A1	N/A	1 MOA	1 MOA	N/A
Colt AR-15A2	N/A	1.25 MOA	0.5 MOA	1 MOA
Colt A2 short sight radius	N/A	1.875 MOA	0.75 MOA	1.5 MOA

Ruger Mini-14	N/A	N/A	1 MOA	1 MOA

Due to the wide variety of ammunition that we find in use today for these rifles, it is impossible to say exactly how many clicks of windage or elevation are necessary to move the bullet a certain number of inches so consider the above click values as "ballpark" figures only.

ZEROING PROCEDURE

Here is what you are going to need to be efficient and successful at this task:

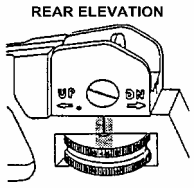
1. Rifle with magazine and 50rds of appropriate ammunition. You should not need this much ammunition but mistakes happen and running out of ammo ruins the process.
2. Manual or printed information that shows the sight adjustment click value at the zeroing distance. This pertains to optics as well.
3. Solid shooting position from prone or bench with a padded rifle rest.
4. Spotting scope or binoculars suitable for viewing .22 caliber holes at the zeroing distance. This eliminates walking back and forth to the target which speeds up the process.
5. Suitable targets, backers, fasteners, and markers.
6. Notebook and pen.
7. All of your usual range safety equipment such as ear/eye protection, etc.
8. A safe range capable of containing rifle projectiles with targets at 25yds and 50yds.

Most rifles will come from the factory with their iron sights pretty well centered in their windage and elevation adjustment range but you should check before you start. With the AR-style sights, ensure that the top edge of the front sight shoulder (flared base) is even with the top edge of the front sight base. The rear sight needs to be centered right-to-left which may be accomplished by lining up the index lines or simply eye-balling if there are no index lines. With the A2 sight, the rear elevation knob should be screwed all the way down with the 6/3 or 8/3 lined up on the left side index line.

The following zeroing steps for the M16A2 are paraphrased from the Colt Manual # CM101 2nd Edition using (M855) 5.56 62gr. FMJ ammunition (you may have to tweak this slightly for your duty ammunition/barrel length but it should be close enough for most duty ammo):

1. Raise the rear elevation knob up one click from bottom and leave it there for the remainder of the zeroing procedure.

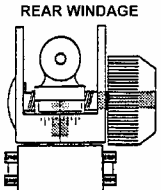
2. Flip the peep sight back so the small unmarked aperture is up. (The small aperture allows more precision which should produce smaller groups that better define the point of impact.) If you have A1 Field Sights, flip the peep sight backwards so that the "L" marked aperture is up. Both A1 apertures are the same size but the forward "L" one is higher and should be used in the same fashion as the A2 small aperture.



3. From a steady position, fire 5rds at the center of the aiming point of the 25yd target to establish a tight group. Compare the center of the group with the aiming point of the target, if they are the same then no further sight adjustment is necessary. If the center of the group does not match the center of the aiming point, measure the distance up/down (elevation) and the distance right/left (windage); example, the fired group hit 1.25" high and 1" left of the aiming point.

4. Calculate the number of clicks required to move the group to the aiming point. Example, the M16A2 moves ½" per click right/left at 100yds which would require 2 clicks right at 100yds to move the sight 1" right, however, we are zeroing at 25yds so each click at this distance moves ¼ of what it does at 100yds so at 25yds so we need 4 times or 8 clicks right here at 25yds to center the sight with the point of aim. The front sight is moved for elevation changes and each click moves the bullet impact up/down 1.25" at 100yds so we would only need 1 click change at 100yds to center our sight vertically; here at 25yds, we need to move the bullet impact 4 clicks counterclockwise to move our bullet impact down 1.25".

5. Turn the windage knob 8 clicks right. Turning this knob clockwise moves the rear sight to the right which moves the bullet impact to the right. The knob is marked an "R" and an arrow that show which direction to turn the knob to make the bullet impact move to the right. Changing the front sight for elevation requires that you move the sight in the **opposite** direction that you want to move the bullet impact. We want the bullet impact to go down 1.25" or 4 clicks; to accomplish this, depress the front sight plunger and "unscrew" the front sight 4 clicks counter-clockwise. This "unscrewing" raised the front sight which will cause the shooter to depress the muzzle lower which will lower our bullet impact. The front sight post is marked with "UP" and an arrow which shows the



direction to turn the sight to move the **bullet impact** up.

6. From a steady position, fire 5rds at the center of the aiming point of the 25yd target to establish another tight group. Compare the center of the group with the aiming point of the target, if they are still out of alignment make whatever minor changes and fire another group. If they are the same then no further sight adjustment is necessary and the rifle is **zeroed** as the point-of-aim now equals point-of impact at 25yds with the small aperture, and a secondary downward zero at 300+yds. This parallels the example of a 25yd zero illustrated on page 11.

7. Set the elevation knob down 1 click down to bottom the 8/3 or 6/3 setting and flip the small aperture down and forward, to bring the large aperture up for future use at the most common ranges of 0-200yds.

8. From a steady position, fire a 5rd group using the large aperture at the 50yd target and this should confirm your large aperture 50yd zero. Point-of-aim should equal point-of-impact at 50yds and the larger aperture may cause some shooter to fire larger groups than expected. Remember this is the "speed" aperture not the precision aperture.

Remember, the above zeroing procedure was for the Colt M16A2 rifle (20" barrel) and the current military service load. Different types of ammunition, barrel lengths, and sight radius can produce different trajectories that may force you to tweak things just a bit but following the above steps will work for most AR systems.

ZEROING OPTICS is basically the same above procedure but with these differences:

- Make sure that the optic is mounted securely, has proper eye relief, and is the right height to line up with the shooters eye when the rifle is raised to the shooting position. The height issue can usually be adjusted by the use of "spacers".

- Often there is little relationship between the optic reticle and the impact of the first fired round so firing that round at a much closer target (10-15yds) or a much larger piece of target paper will ensure that you are able to see that first bullet impact and make any immediate "gross" adjustment changes to get the reticle in alignment with the bore.

- You can also bore-sight the optic. Separate the upper receiver from the lower and remover the bolt carrier group so that you can see clearly through the bore. Place the upper on a firm rest and center the aiming point of the 50 yd target in the center of the field of view that you are seeing through the bore. Without disturbing the upper, move the optic's adjustment until the reticle coincides with the 50 yd target's aiming point.

You are now bore-sighted and your first shot should hit very close to your aiming point. Now you are ready to fine tune.

- Windage and elevation adjustments are all internal inside the optic and you must follow the manufacturer's instructions on how to make these adjustments. Most will have "click" adjustments and their MOA value will be in the instructions and may be inscribed somewhere on the optic as well. Fire your group, calculate the necessary adjustments, make those adjustments, and then fire another group for verification. Repeat until POA = POI.

- Zero on the 50yd target unless you are constrained by your range to only 25yds; if so, most AR optics should be zeroed 1.25" at 25yds in order to attain a true 50yd zero.

ZEROING THE MINI-14 RIFLE is basically the same above procedure but with these differences:

- The front sight of the Mini-14 is not adjustable, so all elevation changes are done with the rear sight. The elevation adjustment is located on top, in front of the rear sight aperture. It also has four positions, and each "click" equals ½ inch change in point of impact at 50 yards. To raise the point of impact, turn the adjustment counter-clockwise. To lower the point of impact, turn the adjustment clockwise.

- The windage adjustment is located on the left side of the rear sight. There are four positions, or detents, for adjustment, held by positive "clicks". One-quarter turn, or one "click", changes the point of impact ½ inch at 50 yards. To move the point of impact to the right, turn counter-clockwise. To move the point of impact to the left, turn clockwise.

- The standard iron-sighted Mini-14 with most types of duty ammunition should use a **20yd** zero distance as noted on page 13.

MARKING ZERO

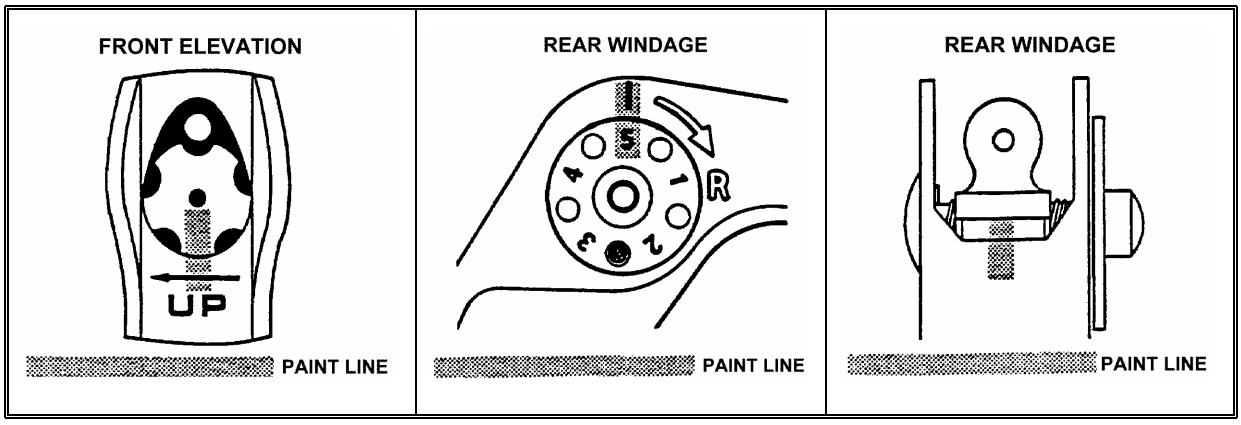
Once you have the firearms zeroed it is a good idea to "mark" the sight settings and this is easily accomplished with a paint pen available at many craft or office supply stores. By making a straight line mark across the edge of the moving adjustment part and the adjacent non-moving surface you have a visual indicator that the adjustment has been moved either intentionally or unintentionally. Curious fingers have been known to twist adjustment knobs just for "fun", and rough handling or tactical gear has also been known to move sight adjustment knobs by accident. See that the two halves of the paint line on an adjustment knob will show you that it has been moved while the paint line on the centered sight itself will show just how many full rotations the knob was turned.

The sight adjustment on optics are generally protected under some type of protected cap and many of those can be "reset" to zero or a known index line that represents zero so a paint line isn't needed. Some other optics without the resettable visual adjustment indicators may find that the addition of a paint line "mark" is helpful as well. This paint line idea can also be used on service pistol not-adjustable sights to determine if they have been knocked out of alignment as well.

This paint line "zero" can also be used as a return point if the sights have to be moved to accommodate the radically different point-of-impact of a particular type of training ammunition or visually challenged shooter. Either should not be enough of an issue, at the ranges that LE normally trains, but if the sights are moved to make these accommodations then you must ensure that everyone is diligent enough to return the sights back to the zero paint line at the completion of the event. Remember this, even with all of the visual indicators lined up, there is no guarantee that these rifles will still be "zeroed" once they are issued out on to the street as the abuse rendered out there can torque things out of alignment. An officer can take a face-plant in the mud while running, or use the barrel as a pry tool; both can bend the barrel with enough pressure. Knowing the casualties of street life, all department rifles should be zero-checked at least once a year with duty ammo to check for this kind of damage. Additionally, all department rifles should be re-zeroed after any change in department-issued duty ammunition. The following are some examples of how to "mark" the AR A1 and A2 sights along with the sights on a Ruger Mini-14:

MARKING ZERO

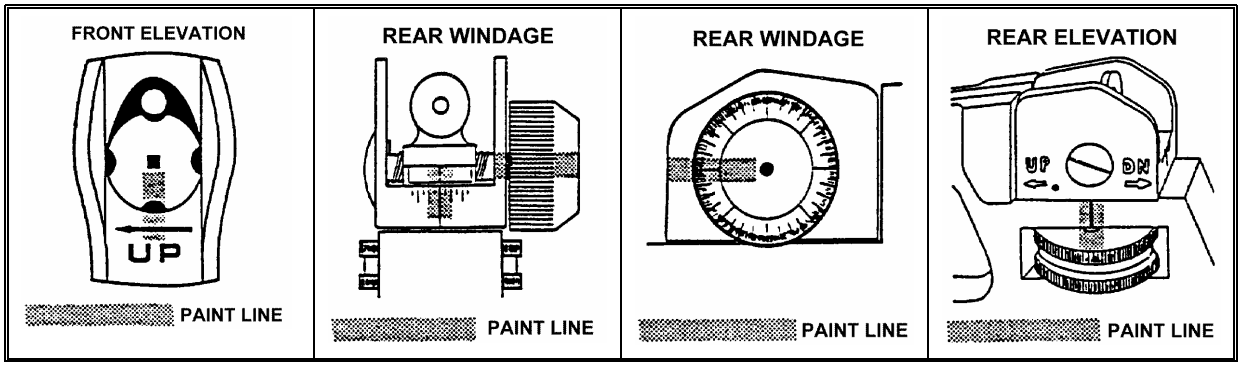
COLT AR15A1



FRONT ELEVATION: Mark ZERO as shown.

REAR WINDAGE: Mark ZERO as shown.

COLT AR15A2

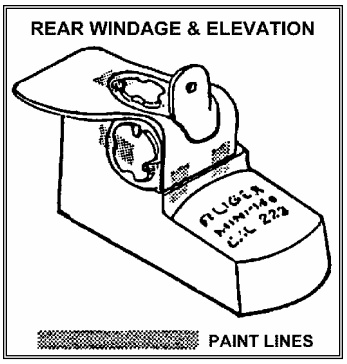


FRONT ELEVATION: Mark ZERO as shown.

REAR WINDAGE: Mark ZERO as shown.

REAR ELEVATION: Turn sight all the way down as far as possible (until bottomed out). Be sure the sight is in a notch. Mark ZERO as shown.

RUGER MINI-14



REAR WINDAGE: Mark ZERO as shown.

REAR ELEVATION: Mark ZERO as shown.

MECHANICAL ZERO

The concept of using "mechanical zero" for zeroing is offered here for you information only as we believe that you should understand the term that others may talk about. While this overly complicate technique may be of value with competitive shooters, we here at CJTC do not believe that it is worthwhile enough to teach to LEOs. You will find a complete description of "mechanical zero" in the Reference section.

Unfortunately, this kind of complicated technique was misunderstood by some, and this has created training program errors that have become urban legends. The US military misconstrued this technique and taught millions of troops that if they remembered how many "clicks" off "mechanical zero" that their personal zero was on their personally issued rifle; they could then pick up any other like rifle from the battle field, find mechanical zero and dial in their "click" data, making that rifle be zeroed for them. ***This is not true!*** Rifles are not all the same like precision instruments and your personal "click" data does not transfer "mechanical zero" from gun to gun. However, let's say you have a fleet of 20 rifles that are all zeroed by the same individual and then that zero is paint-line marked as described above on page 21. If the first fleet rifle required you to crank in 5 clicks right and 2 clicks up to obtain your personal zero, then this personal data would work on the other 19 fleet rifles as well.

The reason for this is simply a matter of semantics; ***"mechanical zero" has nothing to do with a rifle actually being zeroed, it simply means that the sights are in the middle range of their adjustment***. Every rifle that is set at "mechanical zero" has the potential to shoot to a completely different POI when fired at the same target. The reason why it is used as a starting point to begin zeroing of an individual rifle is that it gives you the maximum amount of sight adjustment in all directions. Rifles that are all zeroed by the same individual and then are paint-line marked zero, all have a consistent starting zero point. Now personal data can be used from one rifle to the next with the same amount of precision change.